Journal of International Business and Economy (2008) **9**(2): 1-12 (12 pages)

Journal of International Business and Economy

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CORRELATION OF UNCORRELATED ASSET CLASSES

ABSTRACT

Diversification of a portfolio has long been held as one of the cornerstones of modern portfolio theory and a key driver of investment return over the long term. Correlation is the statistical measure used to quantify diversification. The degree to which asset classes correlate will determine the degree of portfolio diversification (or lack thereof). Many investment products are being sold that claim to be "uncorrelated" with existing portfolio holdings. This paper examines the concept of "uncorrelated" in theory, and conducts a test of correlation utilizing two series of random numbers, as well. For many reasons, labeling products as "uncorrelated" could be incorrect and misleading.

Key Words: correlation, diversification, portfolio, finance, investments, noncorrelated, uncorrelated

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Journal of International Business and Economy
Fall 2008

First Received: Feb. 3rd 2008
Final Revision Accepted: May. 9th 2008

INTRODUCTION

Some investment professionals have said that there are only two decisions most investors make - asset allocation and manager selection. Asset allocation is important because one of the cornerstones of investing theory is diversification. Diversification, in turn, is quantified by correlation. Correlation is the degree to which one asset class's movement will allow inference into how another asset class will move. Correlations can also be done on an investment level basis, as well as on the asset class basis. Naturally, one can also perform correlations on a geographic basis, on a market sector basis, or by comparing any streams of data, though in an investment context correlation is most often calculated using return streams. Correlation is not indicative of causality, but of a statistical relationship that may include causality, but which can also be simply by chance. A portfolio is not considered diversified if all of the holdings are correlated with one another, meaning that if one holding moves a certain way we can predict how the other holdings will move.

An individual investor is not considered to hold a diversified portfolio if he or she owns only one stock. By adding a second stock to the portfolio, a measure of diversification is gained, but this level of diversification is diminished if the second stock goes up and down when the first stock goes up and down (in other words, if the returns of the two stocks are positively correlated). If the investor adds a third stock to the portfolio that does not behave like the first two, then additional diversification is obtained. Mutual funds are a quick and easy way for an investor to gain diversification, since they allow one to own a piece of many different stocks. Often mutual funds are categorized on an asset class basis; for example, one might make a distinction between mutual funds that hold large cap stocks as opposed to those holding growth stocks or value stocks. By adding many different mutual funds with different orientations, the level of diversification is increased yet again. Finally, since the mutual funds described above all might invest in US equities, the investor seeking even greater diversification might invest in fixed income securities, commodities, international debt and equity securities, emerging markets, etc.

There are three broad types of correlation - positive correlation, negative correlation and noncorrelation. Positive correlation occurs when two streams of data are so aligned that knowing how one stream changes will allow inference into how the second stream will change on a direct basis (when one goes up, the other goes up). Negative correlation occurs when the two streams behave in opposition, so that knowing how one stream moves will allow inference into how the second will move on an inverse basis (when one goes up the other goes down). Noncorrelation occurs when the two streams behave independently, so that knowing the movement of one stream does not permit inference into the movement of the second stream. The two streams behave in a random fashion with regard to each other.

There is a long history of literature regarding correlation as it pertains to portfolio diversification, both in scholarly journals and in the popular press. As long as thirty years ago, it was suggested that it may be of little use to have more than ten different securities in a portfolio, unless additional stocks have very low correlation coefficients with existing items (Bierman 1978). One author maintained that most managers either ignored diversification or made use of it in an inappropriate manner in the asset allocation process (Bernstein 1985). Hedberg (1988) emphasized that although it is difficult to predict how prices of individual assets will change, one can be fairly accurate in predicting correlations among the prices of assets. Speidell, Miller, and Ullman (1989) discussed specific risk and correlation, and explained that while diversification may reduce risk, one needs to take the correlation issue into account, as well. Jenkins (1989) demonstrated that an examination of correlations may indicate that some assets with low return and high risk would be suitable for addition to a portfolio. Peavy and Vaughn-Rauscher (1994) discussed correlation in the context of various forms of diversification, such as time, within an asset class, across asset classes, and international. Yasenchak (2003) showed how statistical measures including the standard deviation, the correlation coefficient, and the coefficient of determination are of use in finding the optimal portfolio for an investor. Most recently, one study concentrated not only on the long-term correlations among asset classes, but paid special attention to the amount of variability in those correlations over time (Coaker 2007).

Manager selection is important, because within any asset class many investment professionals can provide products, but there will be variation in results achieved. Asset classes are macro environments and investments are made in subsets of these classes (micro environments). Much research has been conducted regarding the performance of portfolio managers. Among the many methods used to analyze managerial performance have been multicriteria studies (Hababou and Martel 1998), value added approaches (Bradford, Hess, Liang, and McIntosh 1999), and techniques which allow one to measure persistence of managerial abilities over a long period of time (Chua and Koh 2007).

While manager selection may be just as important as diversification (or some might contend more so), this paper is solely concerned with diversification, operationalized by correlation.

The issue of correlation is not trivial. There are investment products that are sold citing three beneficial features to help sell them:

- They are alpha generators (produce return above a benchmark)
- They are inflation hedges
- They are uncorrelated with existing asset classes

Commodities serve as a concrete illustration of the type of product mentioned above. Sellers of commodity based products (whether futures contracts or hard-asset ownership) usually cite those three features (alpha generator, inflation hedge, noncorrelation) as reasons to own commodities. It is the third feature - lack of correlation with existing asset classes - which this paper explores.

At a theoretical level, it is hard to imagine why noncorrelation has been accepted without question or deeper thought. Correlation is a statistical concept that takes a series of results for variables and compares their behavior two at a time. In the case of asset classes, we would be looking at long term returns for the chosen asset classes and comparing the returns two at a time. This casts a wide net and is problematic.

First, commodities are not created equal. There are a wide variety of commodities, from precious metals to industrial metals to energy to foodstuffs to grain, etc., and to believe that they all behave the same relative to other asset classes is too broad a claim to be valid. Taking commodities as a class is too broad when discussing correlation. Just as thinking of US Equities as a group is too broad, even sub-categories such as Small Cap - Growth, Small Cap - Value, Large Cap - Growth, Large Cap - Value, etc. might be too broad, as well.

Second, most portfolios are already intact and distinctly different. In order to make a claim that commodities are not correlated with other asset classes would imply that there are no other asset classes or subclasses in existence that correlate with commodities (hence it is unimportant to know what is in anyone's particular portfolio). Should there be some correlation with other asset classes, this statement could be false if a particular portfolio held those asset correlated classes. You would need to know the specific holdings of the particular portfolio to apply the statement that commodities are not correlated with the holdings in a particular portfolio.

Third, there would seem to be an implicit inference that all other asset classes are correlated. If commodities are not correlated with any other asset class, then all the other classes would have to be correlated with each other, otherwise no diversification could be achieved. It is a statistical improbability that all the other asset classes would have return movements operate in such a fashion that there would be no correlation between or among any of them.

Fourth, noncorrelation for an asset class may not be noncorrelation for a particular alternative within that asset class, and for selections made by a particular manager within a fund within that asset class. Specifics could matter, since the specific fund and holdings are what would be added to a portfolio.

Fifth, there can be different types of noncorrelation. One type of noncorrelation means what people ordinarily think of when they define noncorrelation (essentially that when one variable changes the other variable will behave randomly). Another type of noncorrelation does not operate in that manner. Two series can be uncorrelated if the variables are 100% positively correlated half the time and 100% negatively correlated the other half of the time. It "averages" to noncorrelation, though the reality is highly different.

Perhaps what makes the issue of correlation so interesting is that similar situations can lead to substantially different results. Consider the following small set of data:

Observation	X	Y
1	1	9
2	2	8
3	3	7
4	4	6
5	5	5
6	4	4
7	3	3
8	1	1

The overall correlation is -.096, not even remotely close to being statistically significant. Within the range of observations are two sub-series (broken down as observations 1 to 4 and observations 5 to 8). The correlation of observations 1 to 4 is -1.0 and from 5 to 8 is +1.0 (perfectly negatively correlated and perfectly positively correlated, respectively).

Now consider another small set of data:

Observation	X	Y
1	4	5
2	3	6
3	2	7
4	6	3
5	7	4
6	8	5

The correlation of the first half of the set (observations 1 to 3) is -1.00, and the correlation of the second half (observations 4 to 6) is +1.00, just as above. However, the overall correlation is now .717, which is on the border of statistical significance at the .10 level.

In the first case, we had an overall correlation coefficient that indicated there was no evidence whatsoever of a statistical relationship between the two series. However, embedded within the series were two subsets that had extreme correlation (-1.00 and +1.00, respectively). In the second case the observations were similarly arranged so that the first half of the set of data had a correlation coefficient of -1.00 and the second half had a correlation coefficient of +1.00, yet here the overall result was a nearly statistically significant correlation of .717.

RESEARCH QUESTION

This paper will address the question of whether two series of investment returns that are uncorrelated in the long term are also uncorrelated in the short term. While many investment professionals may not be surprised that noncorrelated asset classes (or investments) can have short-term correlations, the question is whether the frequency and duration of the short-term correlations are what might be expected or whether they exceed some threshold.

RESEARCH DESIGN

Since the definition of noncorrelation is that two series of investment returns will behave randomly relative to each other, the research design will utilize random numbers. There will be two series of 180 random numbers, representing 15 years of monthly returns. The overall correlation of the two series will be found, which should be approximately zero, since the two sets of random numbers should be uncorrelated. Correlations will then be taken in 12 month rolling periods (169 periods). A test of statistical significance of the 12 month rolling correlations will be performed at the .10, .05 and .01 levels. The results for one iteration of this procedure are displayed as Appendix, Table A1.

This procedure will be repeated 110 times and the aggregate number of times each correlation appears recorded in bands, and a percentage taken. So, for instance, if the two series of random numbers had an overall correlation of .002, this would be recorded in the 0 - .0499 band (absolute value). If there were 35 significant 12 month rolling correlations at the .10 level, a mark would be recorded in the 20 - 24% band (since this trial would have had 20.8% of the 12 month rolling correlations test as significant (35/169)). The aggregated results are presented below.

Table 1: Random Correlation Results Distribution

Overall		**Rolling 12 month periods**			
			Significance Level		
Significance Range (abs val)	**Number of Observations**	**% significant**	**0.1**	**0.05**	**0.01**
0 - .0499	58	0 - 4	0	0	3
.05 - .0999	34	5 - 9	0	2	32
.10 - .1499	13	10 - 14	0	6	50
.15 - .1999	5	15 - 19	3	20	19
.20 - .2499	0	20 - 24	14	46	6
.25 - .2999	0	25 - 29	29	24	0
		30 - 34	40	10	0
		35 - 39	14	2	0
		40 - 44	8	0	0
		45 - 49	2	0	0
n	110	*n*	110	110	110
		Minimum correlation to be significant	0.497	0.576	0.708

RESULTS

Overall, the two series indeed test as uncorrelated. The absolute value of the correlations was less than .05 in 53% (58/110) of the trials and from .05 to less than .10 in 31% (34/110) of the trials. Thus, 84% of the trials had overall correlations below .10. There were no overall correlations of .20 or more.

When presenting results for the 12 month rolling correlations, the bands do not reflect the actual correlations, but rather the percentage of statistically significant correlations observed. At the .10 significance level, a statistically significant correlation occurs at an absolute value of .497, at the .05 level a statistically significant correlation occurs at .576, and at the .01 level, a statistically significant correlation occurs at .708.

At the .10 significance level, 26% of the observations were significant from 25 - 29% of the time, 36% were significant 30 - 34% of the time, and in total, 85% were significant more than 25% of the time.

At the .05 significance level, 22% of the observations were significant 25 - 29% of the time, 9% were significant 30 - 34% of the time, and in total, 33% were significant more than 25% of the time.

At the .01 significance level, 45% of the observations were significant 10 - 14% of the time, 17% were significant 15 - 19% of the time, and in total, 5% were significant at least 20% of the time.

DISCUSSION OF RESULTS

At the .10 significance level, all observations were significant more than 15% of the time, precluding the possibility that the significant observations were a result of random chance. At the .05 significance level, all observations were significant more than 5% of the time, again precluding the possibility that the significant observations were a result of random chance. At the .01 level all observations were significant more than 1% of the time (though this is not obvious from Exhibit 2).

The inescapable conclusion is that within each trial of 180 uncorrelated numbers there will be 12 month rolling correlations that are significant. While it can be said that over the long term (15 years) the two series are not correlated, the same cannot be said for the short term (12 months).

CONCLUSIONS AND IMPLICATIONS

There are those asset classes that are sold as being uncorrelated to other asset classes, and investors have been happy with the results of some of these products. It might not be that these products are uncorrelated with the investor's existing portfolio, but rather, positively correlated when the portfolio is increasing and negatively correlated when the portfolio is decreasing. On the whole this might average to noncorrelation, but in reality there is strong correlation that helps the overall portfolio return.

An inference can be made that just the opposite might happen - an uncorrelated asset class might decrease when the portfolio is increasing (negative correlation) and decrease again when the portfolio is decreasing (positive correlation). This could also average to noncorrelation, but the investor would never be happy with the result (as described this asset/asset class is always decreasing) and the portfolio would suffer.

For investors, consideration of only long-term correlations may not be sufficient. For instance, investors would never add an investment to their portfolio using only return data based over 15 years. Investors would ask for returns over 5 years, 3 years, 1 year, 30 days, etc. before making a decision. Likewise, they should not simply accept the long-term correlation, because their concern is really how will the investment correlate with the portfolio over the next 30 days, the next quarter, the next year, etc., rather than how it correlated over the past 15 years. The investment is not coming into the portfolio retroactively, but rather prospectively.

Most investors rebalance their portfolios at certain times. They have target asset allocation models, but as investments do better on a relative scale, allocations can become skewed. Managers then move funds to maintain the target allocations. This paper suggests that correlations should be reviewed on a frequent basis to see if the desired level of diversification continues to be achieved. Investments suffer from style drift, portfolio manager changes, change in focus, etc. Noncorrelation should not be taken for granted, but constantly checked to assure that the portfolio maintains diversification.

REFERENCES

Bernstein, P. L. 1985. Diversification: Old, new, and not-so-new. *Financial Analysts Journal* 41 (2): 22-24.

Bierman, H. Jr. 1978. Diversification: Is there safety in numbers? *Journal of Portfolio Management* 5 (1): 29-32.

Bradford, D., R. C. Hess, Y. Liang, and W. McIntosh. 1999. Attributing manager value added to portfolio performance: A suggested improvement. *Real Estate Finance* 16 (2): 31-37.

Chua, C. T. and W. T. H. Ko. 2007. Measuring investment skills of fund managers. *Applied Financial Economics* 17 (16): 1359-1368.

Coaker, W. J. II. 2007. Emphasizing low-correlated assets: The volatility of correlation. *Journal of Financial Planning* 20 (9): 52-61.

Hababou, M. and J.-M. Martel. 1998. A multicriteria approach for selecting a portfolio manager. *INFOR* 36 (3): 161-176.

Hedberg, A. 1988. Diversification: The proven way to cut risk and protect your profits. *Money* 17 (9): 62-69.

Jenkins, J. W. 1989. Allocating assets: A new look at principles and guidelines. *Journal of Financial Planning* 2 (4): 201-210.

Peavy, J. W. III. and M.-J. Vaughn-Rauscher. 1994. Risk management through diversification. *Trusts and Estates* 133 (9): 42-46.

Speidell, L. S., D. H. Miller, and J. R. Ullman. 1989. Portfolio optimization: A primer. *Financial Analysts Journal* 45 (1): 22-30.

Yasenchak, R. 2003. Using statistical tools in analyzing client portfolios. *Personal Financial Planning Monthly* 3 (3): 17-19.

APPENDIX

Table A1: Random Number Correlation Example - One Iteration

Set 1	Set 2	12 Month Rolling	Set 1	Set 2	12 Month Rolling	Set 1	Set 2	12 Month Rolling	Set 1	Set 2	12 Month Rolling	Set 1	Set 2	12 Month Rolling
44	55	-	2	44	0.5882	47	13	-0.2105	7	6	0.8814	47	54	-0.158
61	20	-	47	15	0.4002	32	63	-0.3524	94	47	0.6139	23	66	-0.8196
59	68	-	82	38	-0.0989	95	1	-0.6339	93	57	0.5311	10	28	-0.1029
98	23	-	49	31	-0.1094	7	18	-0.1564	81	17	0.3865	79	71	0.4028
29	33	-	90	73	0.3234	40	1	-0.2291	4	98	-0.1887	29	22	0.5815
3	73	-	42	18	0.4104	68	30	-0.3223	82	30	-0.1919	63	3	0.1602
85	27	-	76	42	0.8745	22	51	-0.4285	87	40	-0.7891	37	49	0.1292
34	20	-	9	18	0.8206	4	92	-0.6037	88	86	-0.5921	16	56	0.1465
44	96	-	99	44	0.8051	81	37	-0.3547	85	54	-0.6187	45	68	0.0467
23	94	-	75	85	0.6788	76	64	-0.3901	26	40	-0.3982	81	83	0.1796
48	63	-	20	55	0.4323	29	9	-0.333	69	96	0.1729	52	52	0.0486
56	29	-0.5107	97	98	0.5672	49	57	-0.2534	41	11	0.5161	58	96	0.639
32	99	-0.4498	38	71	0.5781	30	75	-0.3304	85	99	0.7224	4	81	0.2793
56	11	-0.8349	3	79	0.091	53	4	0.1042	28	16	0.7609	4	21	0.5181
61	90	-0.5953	90	91	0.7758	54	51	0.202	34	9	0.8841	41	48	0.4942
50	80	-0.4827	86	9	0.0109	92	55	0.1486	64	17	0.8285	81	52	0.2107
73	50	-0.4492	44	17	0.0525	17	52	-0.1654	35	92	0.4793	50	99	0.2873
43	23	-0.2371	95	44	-0.2603	1	40	-0.0534	73	93	0.5539	36	61	0.1763
81	60	0.2515	94	9	-0.3127	25	90	-0.1275	65	87	0.4508	1	51	0.4416
90	87	0.4026	41	17	0.3467	44	71	0.0595	27	9	0.4778	12	86	-0.0708
90	87	0.6309	67	42	0.1226	81	74	0.2437	99	44	0.1299	86	86	0.1548
28	88	0.2788	18	44	-0.1093	70	47	0.2509	62	50	0.18	29	6	0.3771
41	27	0.4583	94	44	-0.0647	19	28	0.3365	24	5	0.6504	54	39	0.2152
42	84	0.2245	69	41	-0.1974	45	9	0.1323	64	45	0.646	61	12	0.027
25	16	0.5327	22	4	0.5472	81	89	0.6693	47	4	0.7872	2	15	0.2629
75	91	0.5385	76	18	0.3432	74	3	0.5183	52	8	0.7277	55	67	0.7095
49	89	0.5048	59	41	0.3174	21	89	-0.0317	85	54	0.8322	23	29	0.4296
75	78	0.705	46	36	0.6329	89	62	0.0674	52	34	0.8371	46	6	0.2887
77	17	0.2141	43	63	0.2045	2	12	0.2116	39	94	0.0017	78	95	0.5915
67	45	0.3217	99	13	-0.1823	32	94	0.062	76	2	-0.2109	58	90	0.7796
44	53	-0.1746	91	86	-0.1446	55	61	-0.0964	19	37	-0.2561	86	100	0.8063
51	78	-0.4872	98	54	-0.0312	22	21	0.3343	19	7	-0.0017	54	93	0.7503
84	79	-0.0493	57	16	0.0789	77	92	0.6342	24	93	-0.3358	7	28	0.7276
47	34	-0.001	35	99	-0.3606	11	44	0.7477	16	89	-0.4076	30	24	0.9003
47	81	0.2506	53	97	-0.4505	29	32	0.639	63	43	-0.478	2	91	0.5472
37	50	0.5114	51	73	-0.2329	41	71	0.8412	42	79	-0.03	3	32	0.5865

Table A2: Tests of Significance

Period	.10 Level		.05 Level		.01 Level	
12 Month Rolling	corr > .497	49	corr > .576	37	corr > .708	21
	corr < -.497	9	corr < -.576	8	corr < -.708	3
	Total	58	Total	45	Total	24
	% of total	34	% of total	27	% of total	14
Total Period	correlation	0.0973				